"Measurement of exposure to a control temperature"

Scope of the Invention

The present invention relates to a device for the detection and quantitative measurement of the exposure of an object to a control temperature taking into account the duration of this exposure, formed by a casing comprising:

- an indication surface,
  which is covered at the visible side with a strip of a porous material which is initially opaque and which forms a migration path,
- a container which contains a measure of migrating material which changes state at a temperature greater than or equal to the control temperature and which then propagates by means of capillary action at a predetermined rate in the porous strip in order to render it transparent by means of gradual impregnation in order to allow the indication surface to appear owing to transparency.

Prior Art

The device for detection and quantitative measurement is intended to monitor the development of a control temperature which must not be exceeded or which must be exceeded only for a predetermined length of time, that is to say, to detect the development of this control temperature and preferably also measure the length of time for which the device has remained above this control temperature.

A device of this type for detection and quantitative measurement of the exposure of an object to a control temperature is already known. This device (Figure 1a) comprises, in a very schematic manner, an indication surface 1 which is illustrated by a graduated scale or graduation with markings or indicia. At the visible side, the indication surface is covered with a strip 2 of porous material which is opaque or which has a very low level of transparency when it is not impregnated or wetted with the migrating material whilst the portions thereof which are impregnated with migrating material are transparent and allow the portions of the indication surface which are located therebelow to appear. The device also comprises a container 3 which contains a measure of migrating material 4. This material, which changes state or viscosity at the control temperature is brought into contact with the porous strip 2. As soon as the detection device is at a temperature t greater than the control temperature tc, the migrating material changes state and impregnates the porous material 2 by progressing therein for as long as it remains in this

state, that is to say, for as long as the temperature thereof remains higher than the control temperature tc. The porous strip 2 constitutes a migration path and the impregnated portion becomes transparent or at least translucent in order to allow the corresponding portion of the indication surface to appear.

Expressed in simple terms, the porous strip 2 is, if necessary, covered with a screen 5 which defines apertures 51, 52 which are distributed along the migration path and which allow the porous strip to appear which, being opaque in the initial state, conceals the indication surface located therebelow.

Figure 1b illustrates the use of the detection device which is assumed to have been exposed to a temperature t greater than the control temperature tc. Under these conditions, the migrating material contained in the container 3 has gradually impregnated the porous strip 2 and has propagated by means of capillary action at a predetermined rate, dependent on the characteristics of the migrating material, the porous material and the temperature to which it is exposed.

When the temperature reaches or exceeds the control temperature, the migrating material progresses in the porous strip but as soon as the temperature of the device falls below the control temperature, the migrating material changes state, coagulates and the progression thereof in the porous strip 2 is stopped. The impregnated portion 21 of the porous strip 2 is illustrated with a solid line. The shaded graduations 11, 12, 13, 14 will thus be visible through the strip 2 in the apertures 51, 52.

In accordance with the information which the detection and measurement device must provide, the entire migration path of the indication surface can be seen which allows the development of the migration path to be monitored in a continuous manner. It is also possible to visualise specific stages of development in order to render the detection or the visualisation easier and more simple; the indication surface thus comprises, for example, coloured zones or pictographs in alignment with the visualisation apertures in order to emphasise the degree of development of the length of exposure time.

Figure 2 schematically illustrates a detection device of this type and the casing 6 or support thereof which receives the various constituent elements, that is to say, the indication surface 1, the strip 2 of porous material and the container 3 containing the measure of migrating material 4. This casing 6 is obviously transparent, at least locally. If

necessary, it can directly include the visualisation apertures (not illustrated).

The container 3 containing the measure of migrating material 4 is placed in the region of the initial end 20 of the porous strip 2 and the indication surface 1.

This indication surface 1 and the porous strip 2 form the migration path which is illustrated in this instance as a straight path. The path may also develop as a path which is wound in helical form or in the form of a circular arc, or in accordance with another pattern, for example, in twists and turns in accordance with the spatial requirement or compact nature which the detection and measurement device may or must have.

Object of the invention

The object of the present invention is to provide a device for detection and quantitative measurement of the exposure of an object to a control temperature of the above-mentioned type, which is simple to produce and which can be readily used, allowing the device to be widely used for applications, in particular domestic ones, such as verifying compliance with the cold chain or monitoring the correct operation of a refrigerator.

Statement and advantages of the invention

To this end, the present invention relates to a detection and quantitative measurement device of the type defined above, characterised by:

- a container which contains the migrating material and which is initially separate from the porous strip, and
- a pushing member which is integrated in the wall of the casing surrounding at least partially the porous strip, which is located in the region of the container and which deforms between
  * a stable neutral form which does not bring the migrating material and the porous strip into contact, and
  * a stable active form which brings the migrating material and the porous strip into contact, the irreversible deformation of the pushing member between the neutral form and the active form thereof being carried out with force.

Since the device according to the invention integrates the means for activating the operation of the device in the casing of the device or a portion of this casing, this facilitates production by reducing the number of components and automating the assembly. Since this pushing

member, which can change from the neutral position or form to the active position or form thereof only by changing shape, requires some degree of force to be applied, there is generally no risk of it being unintentionally deformed and consequently rendered unusable.

The detector according to the invention can be stored, transported or despatched in good conditions without being brought to a particular temperature, that is to say, it can be at ambient temperature without any risk of the migrating material being brought into contact with the porous strip and the device being rendered unusable.

In the same manner, before it is activated, in order to prevent any incorrect recording, the device can first be brought to a low temperature, for example, to the temperature for conserving products, before it is activated itself. Only after it has been brought to temperature is it thus possible to activate it by activating and deforming the pushing member. Furthermore, since the deformation of the pushing member is irreversible, there is no risk of the detection device being deactivated in an untimely manner when it must be in the active state thereof.

In a particularly advantageous manner the pushing member has a convex neutral form and a concave active form relative to the outer side of the device.

The container containing the measure of migrating material can be produced in various manners. An advantageous configuration is characterised in that:

- the container is a porous material which is soaked with a measure of migrating material, and
- the pushing member is located in alignment with the container and the initial end of the porous strip, and when
- the pushing member is in the active form thereof, it presses the container against the end of the porous strip in order to allow the migrating material to pass into the porous strip.

This configuration of the device facilitates large-scale production and measurement of the migrating material since containers of porous material soaked with migrating material can be produced separately from the assembly of the device, that is to say, the positioning of the container, the pushing member and the indication surface with the porous strip.

According to an advantageous feature, the container is a chamber which contains a measure of migrating material and which is

placed in alignment with the initial end of the porous strip, and the pushing member is provided with a pointed portion facing the chamber, at right-angles to the chamber and the initial end of the porous strip; in the active position, the pushing member penetrates the chamber containing the migrating material in order to allow the migrating material to pass into the porous strip.

The device according to the invention is produced in a particularly simple manner in the form of a label comprising:

- a support layer which is provided with the indication surface,
- a porous strip which covers the indication surface,
- an upper layer which covers the porous strip and the support layer and which forms a raised container which accommodates a pellet of porous material which is loaded with the measure of migrating material,
  * this pellet being fixed to the base of the container so as not to be in contact with the porous strip (neutral position),
  * this container being able to be deformed in a remanent manner in the active position and thus bringing the pellet into contact with the porous strip.

The device according to the invention can also be produced as a label which allows automatic detection of the point when a temperature has been exceeded or a prolonged time has been spent at an unauthorised temperature, the label comprising:

- a support layer which is provided with the indication surface,
- a porous strip which covers the indication surface,
- an upper layer which covers the porous strip and the support layer and which forms a raised container which accommodates a pellet of porous material which is loaded with the measure of migrating material,
  * this pellet being fixed to the base of the container so as not to be in contact with the porous strip in a neutral position, and
  * this container being able to be deformed in a remanent manner in the active position, thus bringing the pellet into contact with the porous strip.

In this manner, owing to the invention, the device which is in particular in the form of a label which is associated with a product will prevent the reading or interpretation of the bar code since this bar code will be deformed by the interference element which appears and which simulates a line of the bar code.

However, if the product with which the device is associated has not exceeded the control temperature, the interference element of the device will not appear in the aperture and the bar code will be interpreted normally. The product which is provided with the device will therefore automatically be able to be considered not to have exceeded the control temperature.

Conversely, if this control temperature has been exceeded and the interference element appears as an additional bar of the bar code, the reader will be unable to interpret this bar code and will reject the product associated with this device.

This control operation is particularly simple and in particular can be applied to all forms of bar code owing to the introduction of an interference element which prevents the interpretation of the bar code when this interference element is visible.

The device according to the invention can be produced on a large scale in the form of pre-printed sheets which constitute the support layer provided with the indication surfaces for each device, and which receive the porous strip which is also distributed in the form of a pre-cut sheet and finally an upper layer which covers the porous strip and the support layer in order to form the housing of the pellet of porous material which is loaded with the measure of migrating material. This pellet will be placed beforehand in the housings of the upper layer, this being formed, for example, by means of thermoforming.

After assembly, the strip is cut into labels. Since the housing which forms the container or which contains the pellet of porous material loaded with the measure of migrating material remains spaced-apart from the porous strip, regardless of the physical state of the migrating material, since it is not in contact with the porous strip, the device is not activated. That is to say, the production, assembly and cutting of the detection devices are operations which can be carried out integrally at ambient temperature regardless of the control temperature. It is thus not necessary to assemble the detection devices at a temperature lower than the control temperature which, for low control temperatures, such as those which frozen products or products of this type must comply with, constitutes particularly disadvantageous constraints for large-scale industrial production methods for low-cost products.

Conversely, since this production operation can be carried out at ambient temperature, it is not necessary to install chambers which are

brought to temperature and to operate the production equipment at very low temperatures; this considerably reduces the production cost and allows detection devices to be produced at a cost which is advantageous for their widespread use.

Drawings

The present invention will be described in greater detail below with reference to embodiments which are illustrated in the appended drawings, in which:

- Figure 1, in the portions a and b thereof, is a flow diagram of a device for detection and quantitative measurement of the exposure of an object to a control temperature in accordance with the general principles of the prior art illustrating, in the portion a thereof, the device in a neutral position and, in the portion b thereof, the device after detecting the point at which a temperature has been exceeded for a specific length of time,
- Figure 2 is a view of the temperature detection device and the casing thereof, the whole being in the neutral position,
- Figures 3a to 5b schematically illustrate three embodiments of a device according to the invention with the drawing being limited to the main portion of the device without illustrating the entire development of the migration path,
  * Figure 3a illustrates a first embodiment of a detection and quantitative measurement device according to the invention in a neutral position,
  * Figure 3b is a view similar to that of Figure 3a, after activating the detection and quantitative measurement device,
  * Figure 4, in a similar manner to Figures 3a, 3b, illustrates, in the portion a thereof, an embodiment of the detection and quantitative measurement device in the neutral position and, in the portion b thereof, the use of the device,
  * Figure 5 illustrates, in the portions a and b thereof, as above, another embodiment of a device for detection and quantitative measurement of the exposure of an object to a control temperature, in the neutral position in the portion a thereof and in the active position in the portion b thereof,
- Figure 6 is a sectioned view of a detection and measurement device according to the invention, in the form of a label,
- Figure 7 is a perspective view of another embodiment of a detection and measurement device in the form of a label carrying a bar code.

Description of preferred embodiments

Figures 3a to 5b illustrate a detection and measurement device according to the invention, limited to the left portion as it appears, for example, in Figure 2 corresponding to the initial end of the migration path without illustrating the entire development thereof.

According to the first embodiment (figures 3a, 3b), the device 100 comprises a casing 106 which receives an indication surface 101, illustrated in this instance with a scale or graduations. This surface 101 is covered at the visible side (illustrated with an eye O) with a strip 102 of porous material which is initially opaque, the whole thus defining the migration path. A container 103 which contains a measure of migrating material 104 is placed close to the porous strip 102 but initially not in contact therewith. Finally, a screen 105 is provided which forms an aperture 151 above the migration path.

The container 103 which contains the measure of migrating material 104 is placed above the initial end 120 of the migration path, that is to say, above the corresponding end of the indication surface 101 and the porous strip 102. In alignment with the container 103, the casing 106 comprises a pushing member 107 having a convex form relative to the outer side when the pushing member is in the neutral position (or form) thereof or non-activated position illustrated in Figure 3a.

At this time, the pushing member 107 does not activate the container 103 and the container is separated from the porous strip 102 so that the migrating material 104 remains confined in the container 103 and cannot pass into the porous strip 102 and migrate therein.

In order to use the detection device 100 which is, for example, associated with a product for which it is desirable to monitor the point at which the control temperature tc which corresponds to a conservation temperature is exceeded, after the detection device 100 has been positioned, the pushing member 107 is activated in order to deform it using force and cause it to change from the neutral form (Figure 3a) to the active form 107a thereof (Figure 3b).

The pushing member is retained in the neutral form thereof by means of its inherent stability. In order to cause it to change into the active form 107a thereof, it is necessary to apply a degree of deformation force (arrow A) in order to pass the metastable position. This force is dependent, for example, on the characteristics of the material or, more generally, on the mechanical characteristics of the pushing member. This

transformation is irreversible, the pushing member being deformed from one form to the other by passing through a metastable form or state so that it is forced towards the active position thereof and is retained at that location. In the active position, the pushing member 107a presses the container 103 of the measure of migrating material 104 against the porous strip 102 so that, if the control temperature is exceeded, the migrating material 104 passes into the porous strip 102 by means of capillary action and impregnates it by progressing therein in accordance with the temperature of the device and the length of time for which the device is exposed to this temperature which is greater than the control temperature. The impregnation of the porous strip 102 by the migrating material renders the porous strip transparent. This state is schematically illustrated in Figure 3b which illustrates the porous material replaced over the initial portion of the length thereof with a solid continuous line 121 which illustrates the impregnation thereof. The entire portion of the porous strip (portion illustrated with a continuous line) is transparent or at least translucent and, in any case, at the visible side, it allows the indication surface to appear. In the example illustrated, this surface appears through the aperture 151. In the absence of any aperture, the entire graduation of the indication surface 101 covered with the continuous line 121 illustrating the portion of the porous strip that has become transparent can be seen.

Figure 4 illustrates a variant 200 of the device of the invention according to Figure 3. In this variant, the porous strip 202 is not placed between the indication surface 201 and the container 203 in the region of the initial end of the migration path but instead above the container 203, below the pushing member 207 which is of the same type as that of Figure 3, integrated in the material of the casing 206.

In the neutral position (Figure 4a), the porous strip is not in contact with the container 203 which contains the measure of migrating material 204 and the pushing member has a convex form relative to the outer side.

When the pushing member 207 is pressed as indicated by arrow A, with the pushing member being deformed with force, it is caused to change into the active form or position 207a thereof, which is concave relative to the outer side. In this stable active position, the pushing member 207a presses the porous strip 202 against the container 203 containing the measure of migrating material. If the device is then exposed

to a temperature greater than the control temperature, the migrating material passes from the container into the porous strip 202 and gradually migrates therein in accordance with the length of exposure time, as has been explained above. The impregnated portion of the strip 202 is illustrated by a solid line 221. The detection and quantitative measurement of the exposure of the object to a temperature greater than the control temperature are carried out under the same conditions as those described above with reference to Figure 3.

Figure 5 illustrates, in the portions a and b thereof, another embodiment of the detection and measurement device 300 according to the invention. In this instance, the pushing member 307 integrated in the casing 306 has a similar form to that described above: a convex form, curved towards the outer side in a stable neutral position, and a concave form directed towards the inner side of the chamber in a stable active position. The change from the neutral position to the active position is carried out by applying a degree of force (arrow A). However, in a variant of the previous embodiments, the pushing member 307 comprises a spindle 308 which, in a neutral position, does not touch the container 303 containing the measure of migrating material 304. In an active position, the spindle 308 penetrates the container 303, thus allowing the migrating material to pass into the porous strip 302 when the temperature conditions are established (temperature greater than the control temperature). The other portions of the device 300 which are identical to those of the embodiments are identified with similar reference numerals but the description thereof will not be repeated.

Figure 6 is a schematic section of an embodiment of a detection and quantitative measurement device in the form of a label. This label 400, which is illustrated in section, comprises a support surface 401 which carries, for example, the indication surface in the form of a graduation. This support surface 401 is covered with a strip 402 of porous material and the whole is covered with an upper layer 406 which forms the casing. This upper layer 406 is adhesively-bonded or welded to the support surface 401. The upper layer delimits a projection 407 which contains a pellet 403 which forms a container and which is impregnated with the measure of migrating material.

The end of this label 400 comprises an aperture 410 for the passage of a fastening member 411 which is illustrated with a circle, for example, for fixing the label to a product. The support 401 can also be

provided with an adhesive zone, for example, a double-sided adhesive which is covered over the outer face thereof with a peelable layer in order to allow the label 400 to be adhesively-bonded to a product or object for which it is desirable to monitor the temperature development.

The arrow A placed above the projection 407 indicates the activation of the detection device by means of pressing on the projection 407 in order to deform the projection 407 in a remanent manner and bring the pellet 403 into contact with the porous strip 402 and activate the operation of the detector.

The label 400 which has been illustrated in this manner can be produced on a large scale and at ambient temperature by using a pre-printed sheet which contains the indication surfaces of the labels to be produced; strips of porous material are placed on this sheet, then the upper layer is placed in position, preformed with housings which have been provided beforehand with soaked pellets.

This upper layer is then sealed to the lower layer by enclosing the porous strip and the pellets which have been impregnated with measures of migrating material.

Finally, the whole is cut in order to produce individual labels or batches of labels.

This production technique is very similar to printing techniques or production techniques for “blister” packagings.

Figure 7 is a perspective view of another form of detection and measurement label 500 according to the invention. This label has the structure of that of Figure 6, apart from the fact that the casing 506 covering the migration path formed by the indication surface which is covered by the strip 502 of porous material is opaque and comprises only one aperture 551 at a precise location. The upper side of the label carries a bar code 510.

The indication surface is provided with printed matter in the form of a bar code line in the region of the aperture 551.

When the label 500 has been activated and has not exceeded the control temperature, the line of the indication surface does not appear through the aperture 551 and the bar code 510 can be read normally.

However, if the label has exceeded the control temperature and the migrating product has migrated into the strip of porous material as far as the region of the aperture 551, the strip which has become transparent allows the bar code line to appear in the aperture.

This bar code line constitutes an interference element since it is added to the other lines of the bar code and makes it impossible to read the bar code.

This simple means allows automatic detection of whether or not a label has exceeded the control temperature for a fixed length of time. This length of time can be very short in accordance with the migration path.

This thereby allows products which have exceeded the control temperature to be automatically removed. In the example of an automatic checkout, the bar code of the product will not be able to be read and the product will thus be automatically rejected.